# BOTANICAL SURVEY ALONG THE YELLOWKNIFE HIGHWAY, NORTHWEST TERRITORIES, CANADA

## II. VEGETATION

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During field work along the Yellowknife Highway in 1958, 1959, 1961, and 1962 I was engaged in two major procedures: (1) the making of a plant collection to document the flora, and the recording of distributional, phenological, life-form, and other data; and (2) the carrying out of a primary survey of the vegetation, that is, recognizing and describing the major plant communities and listing their floristic composition. Part I of *Botanical Survey along the Yellowknife Highway,* also published in SIDA (Thieret, 1963), contains a brief introduction, a map of the highway region, and an annotated catalogue of the flora. The present paper contains (1) additional data to characterize the region and (2) descriptions of the following: forest vegetation; vegetation of rock outcrops; vegetation of lakes and rivers; vegetation of marl and gypsite deposits; vegetation of strands and islands; vegetation of sand plains; and vegetation of disturbed soil. I have already described grassland vegetation of the region (Thieret, 1959). Descriptions of vegetation in areas adjacent to the highway region have been published by Cody, 1960; Jeffrey, 1961; Moss, 1953a, 1953b, 1955; Porsild, 1945, 1951; Raup, 1935, 1946, 1947; and Thieret, 1961. The reader is referred to these papers for comparison with the present account.

Climatological data are given in Table 1. The climate of the highway region can best be described as northern continental, with short, dry, relatively warm summers and long intensely cold winters. The growing season is short and hazardous. Freezing and below freezing temperatures may occur even in July and August. Nevertheless, there is an average frost-free period ranging from 83 days at Fort Providence to 113 days at Yellowknife. Snowfall is heavy, but annual precipitation is low, averaging about 10 inches, of which somewhat more than half (about 5.5 inches) falls as rain. Much of the rain (about 3.6 inches) falls in July and August. More rain falls in autumn than in spring. The low annual precipitation is compensated for in part by the presence of permafrost—which retards drainage, accounting for some of the vast amount of surface water in the region—and by the relatively low summer evaporation.

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Day length data for Yellowknife are given in Table 2. The length of the summer days is notable from the standpoint of plant growth. During the longest days, there is twilight illumination during the night because the sun remains just below the horizon.

Data and numerous references concerning the geology of the highway region are given by Douglas (1959) and Raup (1946, 1947) and need not be repeated here. The Yellowknife Highway lies partly in the northern Great Plains and partly in the Canadian Shield. For approximately the first 66 miles (from Enterprise) the road runs along the northern edge of the Alberta Plateau (a division of the Great Plains). Elevation ranges from about 650 to 875 feet. On the great descending steps of the plateau—and also on the risers—considerable limestone of Palaeozoic age is exposed. Marly lakes are frequent, as are extensive peat and lake marl deposits and swift, cold, clear streams with rocky or sandy beds. Sandy or gravelly soils mantle many of the ridges. One major river, the Kakisa, averaging 200 feet wide, crosses the highway at about mile 54. The Kakisa bridge is welcome as affording the only bit of paved road along the highway outside of Yellowknife. Lady Evelyn Falls on the river is 47 feet high. It and Kakisa Lake (elevation 729 feet) are accessible via "Kakisa Road," which leaves the highway at mile 53 and goes 10 miles to the lake. The lake, about 25 miles long and 8 miles wide, has, in the few places I investigated it, a low, rocky,

Table 1. SELECTED CLIMATOLOGICAL DATA FOR YELLOWKNIFE, HAY RIVER, AND FORT PROVIDENCE, N.W.T.*

| | *Yellowknife* | *Hay River* | *Fort Providence* |
|---|---|---|---|
| Mean annual precipitation, inches | 8.45 (10 years) | 12.02 (29 years) | 9.63 (10 years) |
| Mean annual rainfall, inches | 5.00 (10 years) | 7.34 (29 years) | 5.35 (10 years) |
| Mean rainfall, June, July, and August, inches | 2.90 (10 years) | 4.06 (29 years) | 4.13 (10 years) |
| Mean temperature, January, F | -18 (10 years) | -12 (29 years) | -17 (9 years) |
| Mean temperature, July, F | 60 (10 years) | 60 (29 years) | 60 (9 years) |
| Extreme high temperature, F | 86 (1941-1960) | 96 (1893-1959) | 97 (1943-1959) |
| Extreme low temperature, F | -60 (1941-1960) | -62 (1893-1959) | -60 (1943-1959) |
| Average frost-free period | 113 days (10 years) | 88 days (53 years) | 83 days (7 years) |

* Data in lines 1 through 5 from Anonymous, 1954; in lines 6 and 7 from Meteorological Branch, Department of Transport, Toronto, *in litt.*; in line 8 from Anonymous, 1956. Lengths of time on which the data are based are given under each entry.

and sandy shore. Several hundred feet from its southern shore is a high escarpment in which considerable limestone is exposed.

At mile 66 the highway leaves the plateau and descends to the Mackenzie Lowlands (also a division of the Great Plains), in which it remains until it enters the Canadian Shield at Frank Channel. The Mackenzie River, crossed by a ferry, is reached at mile 82; here it is slightly more than a mile wide and is 513 feet in elevation. After the crossing, the highway runs atop the river bluff for 4 miles and then turns northeast. At about mile 4 N, a branch road nearly 4 miles long runs to Fort Providence.

The Mackenzie Lowlands, an area of low relief, is generally poorly drained and muskeg covered. The watercourses, for the most part, are sluggish and have muddy beds. Many of the lakes have marly bottoms, and there are many small to large deposits of marl. Maximum elevation along the highway, about 900 feet, is in the area between mile 90 N and 105 N, where sand deposits, outcroppings of limestone, and numerous sinkholes occur. Gypsum is near the surface, and there are several small lakes in which gypsite has been deposited. Perhaps the most scenic portion of the highway is at about mile 120 N, where the road descends into the valley of Mosquito Creek. Here can be seen a splendid panorama of massive limestone escarpments, dense forest, and, in the distance, the waters of Great Slave Lake. Extensive sand deposits are found between Mosquito Creek and Frank Channel.

Several great Pre-Cambrian outcrops, not easily accessible from the highway, represent outliers of the Canadian Shield and can be seen from the road several miles before it enters the shield at Frank Channel. The 58 miles from the channel to Yellowknife are totally different in aspect from the remaining 222 miles of the highway. Generally low rounded outcrops of Pre-Cambrian rock with intervening lakes or marshes are the dominant feature of the landscape. In the vicinity of Yellowknife occur large sand deposits.

The Yellowknife Highway lies wholly within the boreal forest although certain limited areas along it are strikingly reminiscent of the lichen woodland of the boreal forest-tundra ecotone. The predominating vegetation is, of course, forest of various types. However, the

Table 2. APPROXIMATE TIMES OF SUNRISE AND SUNSET, AND DAY LENGTH FOR SELECTED DATES, YELLOWKNIFE, N.W.T.*

| *Date* | *Sunrise* | *Sunset* | *Day length* |
|---|---|---|---|
| | *Mountain Standard Time* | | *Hrs.-Mins.* |
| May 25 | 3:14 AM | 9:45 PM | 16 - 48 |
| June 25 | 2:40 AM | 10:38 PM | 19 - 58 |
| July 25 | 3:37 AM | 9:47 PM | 18 - 10 |
| August 25 | 5:03 AM | 8:13 PM | 15 - 10 |
| September 25 | 6:26 AM | 6:27 PM | 12 - 01 |

* Data supplied by H. W. Murdy, United States Bureau of Sport Fisheries and Wildlife.

forest cover is by no means continuous but is broken by grasslands, rock outcrops, shrub communities, numerous lakes and watercourses, and clearings.

The flowering season is brief, lasting only about 2½ months. The first herbaceous species to bloom appear to be *Calypso bulbosa* and *Anemone patens* var. *wolfgangiana*. By the time of my earliest arrival at the highway, June 13, *Calypso* had half-mature-size fruits as well as flowers; the pasque flower was through blooming, and its fruits were about half grown. By this time, most willows are past the height of flowering, as are *Arctostaphylos rubra* and *Rhododendron lapponicum*. The peak of the flowering season is during the last week of June and the first two weeks of July. Goldenrods *(Solidago)*, beginning to bloom in mid-July, are the harbingers of a fleeting fall, which is well upon the region by August 1, when the fringed gentians *(Gentianella crinita* ssp. *macounii* and ssp. *raupii)* and *Lomatogonium rotatum* open their flowers. After these, only two species of *Artemisia*, unlikely stragglers (they may well be introductions from areas to the south), are left to bloom; they come into flower in mid-August.

During the course of the field work, and after I had gained some familiarity with the local vegetation, attention was concentrated upon what might be called the "typical" stands of certain vegetation types, and notes were made on each such stand observed. It must be emphasized that data were gathered only for readily recognizable vegetation types and that little serious attention—because of time limitations—was paid to the many stands that were not of these types and that were seemingly difficult of classification into definable communities. It is one thing to recognize and describe "typical" jack pine forest or marly-lake vegetation and to refer these to community type(s); it is another altogether to attempt to refer to community type a stand in which all tree species known in the highway region grow in close association or a stand that is a "typical" black spruce-*Sphagnum* forest in all respects except one: the trees are not black spruces but are jack pines. Such stands as these actually exist and, with many others that are of different nature but are equally or more perplexing, constitute a large percentage of the vegetation along the highway. The vegetation types described in the following pages make up perhaps a smaller percentage of the total plant cover than do the vegetation types I have not attempted to describe. The former are obviously no more important than the latter—they are merely easier to characterize and categorize.

## FOREST VEGETATION

### BLACK SPRUCE FOREST

The commonest type of forest in the highway region is that dominated by *Picea mariana*. Black spruce forests occupy the wettest of the forest-dominated areas, ranging from deep, peat-filled (or peat-and marl-

filled) depressions to shallow depressions, slopes, and level land. The forests vary considerably in development and floristic structure. Where they occur in deep, peat-filled depressions they represent an advanced stage in hydrarch succession and may be designated as bog (or muskeg) forests; elsewhere, they develop where moisture relations favor black spruce over more mesic tree species.

The bog forest—in its wetter phase—is characterized particularly by an abundance of *Sphagnum* (especially *S. fuscum* and *S. warnstorfianum;* also *A. capillaceum* var. *tenellum),* which forms great hummocks that serve as substratum for the trees and other plants of the forest. In the wettest places *Sphagnum girgensohnii* and *S. squarrosum* may occur. Fruticose, mat-forming lichens of the genera *Cetraria* and *Cladonia* may be abundant. The forest is underlain generally by considerable peat (below which is marl in the case of succession from a marly lake). Usually a distinct low shrub stratum, composed principally of *Ledum decumbens* or *L. groenlandicum* or both, is present. In the depressions between the *Sphagnum* hummocks (where there may be standing water) can occur various plants (e.g., *Triglochin maritima, Carex aquatilis, Eriophorum chamissonis, Scirpus cespitosus* var. *callosus, Menyanthes trifoliata, Utricularia* spp.) that do not "belong" to the forest community but are remnants of preceding successional stages.

A common associate of black spruce in the bog forest is *Larix laricina,* larch, which occurs usually as isolated trees (rarely in stands of limited extent). Among other especially common or characteristic plants of the forest are: *Equisetum palustre, Selaginella selaginoides, Smilacina trifolia, Tofieldia glutinosa, Ranunculus lapponicus, Drosera rotundifolia, Parnassia multiseta, Rubus chamaemorus, Oxycoccus microcarpus, Vaccinium vitis-idaea* var. *minus, Pinguicula vulgaris,* and *Senecio lugens.*

The bog forest, in its drier phase, shows ascendancy of woodland mosses, especially *Hylocomium splendens,* over the *Sphagnum. Hylocomium* does not grow in hummocks like *Sphagnum* but produces a relatively even carpet over the forest floor. Such forests, where *Hylocomium* has become the dominant ground cover and *Sphagnum* has disappeared altogether or is restricted to isolated hummocks, may be floristically almost identical with black spruce forests that have developed on sufficiently wet shallow depressions, slopes, or level land, as described below.

Black spruce forests that develop on shallow depressions, slopes, or level land that are sufficiently wet to preclude other forest types are distinct from the wetter phase of the bog forest in their history and floristic composition; with the drier phase of the bog forest, as mentioned in the preceding paragraph, they intergrade floristically. They are characterized particularly by a continuous carpet of *Hylocomium splendens* and other woodland mosses. In some black spruce-*Hylocomium* forests, *Sphagnum* is absent; in others it occurs in scattered hummocks. The

forest is underlain by a shallow layer of peat, as little as 4 inches, in contrast with the deep peat under the bog forest. An obvious low shrub stratum is generally lacking or poorly developed. The plants that are especially common or characteristic of the bog forest are uncommon or lacking in the black spruce-*Hylocomium* forest, which is floristically similar to the white spruce-*Hylocomium* forest and intergrades therewith. Species especially common or characteristic in the black spruce-*Hylocomium* forest (in contrast to the bog forest) are: *Peltigera aphthosa, Juniperus communis* var. *depressa, Zygadenus elegans, Mitella nuda, Rosa acicularis, Rubus pubescens, Hedysarum* spp., *Moneses uniflora,* and *Linnaea borealis* var. *americana.*

The many stands of black spruce along the highway include not only excellent examples of typical bog forests and typical black spruce-*Hylocomium* forests but also, as has already been indicated, every degree of intergradation between the two. One of these examples of intergradation is worth mentioning. Near mile 120 N is a black spruce stand that floristically is a fine example of a bog forest—but which has not developed through hydrarch succession: the *Sphagnum* hummocks rest upon only about 6 inches of peat that, in turn, overlies white sand (the sand here is at least 5 feet deep, as can be seen in the nearby road cut). The site is on a slight rise, which only adds to the perplexity.

Higher plants (in addition to *Picea mariana)* observed in black spruce forests are listed here (those followed by (S) were seen only in bog forests; those followed by (H) were seen only in black spruce-*Hylocomium* forests; the others were observed in both types): *Equisetum arvense, E. palustre* (S), *E. scirpoides, E. sylvaticum, Selaginella selaginoides* (S), *Juniperus communis* var. *depressa* (H), *J. horizontalis* (H), *Larix laricina, Triglochin maritima* (S), *Calamagrostis neglecta* (H), *Oryzopsis pungens* (H), *Carex buxbaumii* (H), *C. scirpoidea* (H), *C. vaginata* (H), *Eriophorum chamissonis* (S), *Scirpus cespitosus* var. *callosus* (S), *Smilacina trifolia* (S), *Tofieldia glutinosa* (S), *T. pusilla, Zygadenus elegans* (H), *Calypso bulbosa* (H), *Corallorhiza trifida* (H), *Cypripedium calceolus* var. *parviflorum* (S), *C. guttatum* (H), *Habenaria hyperborea, H. obtusata, Spiranthes romanzoffiana, Salix candida, S. glauca, S. myrtillifolia, Myrica gale, Betula glandulosa, Geocaulon lividum, Polygonum viviparum, Arenaria humifusa* (H), *Anemone parviflora, Ranunculus lapponicus* (S), *Drosera rotundifolia* (S), *Mitella nuda* (H), *Parnassia multiseta, Ribes hudsonianum, Dryas integrifolia, Potentilla fruticosa, Rosa acicularis* (H), *Rubus acaulis* (H), *R. pubescens* (H), *Hedysarum alpinum* var. *americanum* (H), *H. mackenzii* (H), *Empetrum nigrum, Viola nephrophylla* (H), *Shepherdia canadensis, Cornus canadensis, Moneses uniflora* (H), *Pyrola asarifolia, P. grandiflora* (H), *P. virens* (H), *Andromeda polifolai, Arctostaphylos rubra, A. uva-ursi* (H), *Chamaedaphne calyculata, Kalmia polifolia* (H), *Ledum decumbens, L. groenlandicum, Rhododendron lapponicum, Oxycoccus microcarpus* (S), *Vaccinium uligi-*

*nosum*, *V. vitis-idaea* var. *minus*, *Castilleja raupii* (H), *Pedicularis labradorica*, *Pinguicula vulgaris* (S), *Galium labradoricum* (H), *Linnaea borealis* var. *americana* (H), *Viburnum edule* (H), *Antennaria pulcherrima* (S), *Erigeron hyssopifolius*, *Senecio lugens* (S), and *Solidago multiradiata*.

## WHITE SPRUCE FOREST

White spruce *(Picea glauca)* forests occur generally on the mesic forest-occupied sites, and especially on moist well-drained uplands and along watercourses. In young stands that have arisen following fire, the trees are small and closely spaced, the floor is shallowly covered with litter, and the associated plants are few in species and numbers, e.g., scattered lichens, *Rosa acicularis*, *Shepherdia canadensis*, *Epilobium angustifolium*, *Cornus canadensis*, *Pyrola secunda*, *Arctostaphylos uva-ursi*, *Vaccinium vitis-idaea* var. *minus*, and *Linnaea borealis* var. *americana*. Travel through such stands is difficult because of the dense growth and the brule.

Quite another picture is presented by a mature white spruce forest, of which the finest example to be seen along the highway is on the steep slope above Kakisa River about ½ mile below Lady Evelyn Falls. The trees are large, the biggest seen being 28.1 inches DBH, about 129 feet tall, and about 183 years old. They cast a dense even shade. The floor is deeply carpeted with *Hylocomium splendens* into which the walker sinks 3 or 4 inches at every step. The moss and peat layer is thick enough so that, when I was trying to dig through it in several places, I struck frozen peat (about 16 inches down in mid-July) before I was able to reach mineral soil. Reproduction of the spruce is good. *Cladonia rangiferina* occurs in small scattered patches, and *Peltigera apthosa* is common. *Alnus crispa*, to about 8 feet tall, forms a more or less definite understory. Parasitic on the roots of the alder, and very rare, is *Boschniakia rossica*, the only Orobanchacea known in the region. Other plants in the forest are much scattered and include the shrubs *Juniperus communis* var. *depressa*, *Rosa acicularis*, *Shepherdia canadensis*, *Arctostaphylos rubra*, *Ledum groenlandicum*, *Vaccinium vitis-idaea* var. *minus*, *Linnaea borealis* var. *americana*, and *Viburnum edule;* and the herbs *Cystopteris montana*, *Carex concinna*, *Corallorhiza trifida*, *Cypripedium guttatum*, *Geocaulon lividum*, *Actaea rubra*, *Hedysarum mackenzii*, *Mitella nuda*, *Moneses uniflora*, *Pyrola asarifolia*, and *P. grandiflora*.

On the slope above the south shore of the Mackenzie River (mile 80-81) the white spruce forest is younger than the Kakisa stand, being composed of trees 45-55 years old. Balsam poplar is frequent. About 75 per cent of the floor is covered with deep litter (3 to 5 inches), the rest with mats of *Hylocomium splendens* about 5 inches thick and a few small patches of *Cladonia*. The moss cover is more complete in the most

densely shaded part of the forest, where *Hylocomium* and *Cladonia* are the only plants other than the trees. In addition to the plants seen in the Kakisa stand( but with the exception of *Boschniakia rossica)*, the following were observed here: *Calypso bulbosa, Habenaria obtusata, Salix myrtillifolia, Ribes lacustre, Fragaria virginiana* var. *terraenovae, Rubus acaulis, Lathyrus ochroleucus, Empetrum nigrum, Pyrola virens,* and *Pedicularis labradorica.*

The white spruce forest richest in secondary species, and the most open one seen, is on the slope above Mosquito Creek. The floor is densely carpeted with *Hylocomium splendens; Tomenthypnum nitens* is frequent, as are *Peltigera aphthosa* and *Cladonia. Sphagnum* hummocks are occasional. Considerable brule, well decayed, is present. The following secondary species, none common, were observed here: *Equisetum arvense, E. scirpoides, Juniperus communis* var. *depressa, J. horizontalis, Carex capillaris, C. capitata, C. gynocrates, C. vaginata, C. scirpoidea, Tofieldia pusilla, Zygadenus elegans, Calypso bulbosa, Corallorhiza trifida, Cypripedium passerinum, C. guttatum, Habenaria obtusata, Orchis rotundifolia, Salix glauca, S. myrtillifolia, S. reticulata, Myrica gale, Geocaulon lividum, Anemone parviflora, Dryas integrifolia, Potentilla fruticosa, Rosa acicularis, Hedysarum alpinum* var. *americanum, Empetrum nigrum, Shepherdia canadensis, Moneses uniflora, Pyrola grandiflora, P. virens, Andromeda polifolia, Arctostaphylos rubra, Ledum groenlandicum, Oxycoccus microcarpus, Rhododendron lapponicum, Vaccinium uliginosum, Vaccinium vitis-idaea* var. *minus, Castilleja raupii, Pedicularis labradorica, Linnaea borealis* var. *americana, Viburnum edule,* and *Solidago multiradiata.*

The Kakisa and Mackenzie stands of white spruce are typical of most stands of white spruce of similar age that are to be seen along the highway; the Mosquito Creek stand is distinctly atypical because of its openness and relatively large number of secondary species. Many stands of white spruce are closely similar to mature stands of jack pine except for the presence or relatively greater abundance of *Hylocomium splendens.* White spruce forests, then, are characterized typically by a ground cover of *Hylocomium splendens* or of this moss and thick litter; by relatively dense shade; and by a low number of secondary species—and of individuals of these species. Many of them have scattered balsam poplars. In stands of white spruce other than those previously mentioned, the following additional species were found: *Rhytidium rugosum* (common as ground cover, with *Hylocomium splendens,* at mile 22.7; this species, inadvertently omitted from the *Catalogue,* was determined by William D. Reese), *Cladonia alpestris, Elymus innovatus, Ribes triste, Astragalus americanus. Arctostaphylos uva-ursi, Lonicera dioica* var. *glaucescens,* and *Galium septentrionale.*

Those examples of mature white spruce forest examined by me appeared to be self-perpetuating, i.e., good reproduction of spruce was

shown and no other tree species appeared as invaders. Following fire, the spruce may regenerate itself, or its place may be taken by jack pine or aspen. White spruce may form pure stands, or forests of this species may contain few to many individuals of other tree species, notably jack pine, aspen, and poplar, but also larch and black spruce. Similarly, white spruce may occur in forests that are primarily of other species.

## JACK PINE FOREST

Dry sandy or gravelly ridges and flatlands are typically covered with forests in which *Pinus banksiana,* jack pine, is the sole or by far the commonest tree species. Many acres, relatively recently burned, are dominated by a scrubby growth of pine on mineral soil. Here, walking may be exceedingly onerous because of the brule and the dense growth of young trees. Such sites may be barren of plants except for the pines or there may be occasional *Rosa acicularis, Shepherdia canadensis, Epilobium angustifolium, Arctostaphylos uva-ursi, Vaccinium vitis-idaea* var. *minus,* and *Linnaea borealis* var. *americana.* As such forests age, there is gradually increasing mesophytism. Woodland lichens, herbaceous plants, and shrubs return and increase in abundance; a litter and humus layer accumulates; many of the pines die out. Well developed jack pine forests that are approaching maturity are parklike in aspect and are characterized by rather widely spaced trees that are 35-55 feet tall, at least 40 years old, and, for the most part, even-aged. The undergrowth in such forests is scanty. The floor may be covered largely with litter or with litter and humus or it may show extensive development of lichens, especially fruticose *Cetraria* and *Cladonia.* The most common and characteristic low woody plants are *Rosa acicularis, Shepherdia canadenis, Arctostaphylos uva-ursi,* and *Vaccinium vitis-idaea* var. *minus.* The *Arctostaphylos* and *Vaccinium* are common to abundant as ground-cover plants. *Calamagrostis purpurascens* and *Elymus innovatus* are characteristic grasses. In places, *Alnus crispa,* to about 8 feet tall, forms a definite understory. Jack pine appears not to reproduce well in the shade, so young pines are not to be found in the forest.

Jack pine forest of this type occupies the upper parts of ridges and the most xerophytic of the flatlands. In such sites it may be regarded as an edaphic or pyric climax, being maintained not only by the xerophytism of the habitat but also by recurrent fires. In such a habitat I found no jack pine forest more than 70 years old. It is not uncommon to see, on one part of a sandy ridge, a mature pine forest as just described and, on an adjacent part of the ridge, a burned-over area with still-standing dead trees and a dense growth of small young pines. These trees may bear cones when they are only 3 feet tall.

On more mesophytic sites (e.g., the lower flanks of ridges) the successional trend is obviously toward the replacement of jack pine by white spruce. As the pine forest matures, the litter and humus layer

deepens, woodland mosses (especially *Hylocomium splendens)* appear in scattered patches, and *Picea glauca* becomes established. In such a forest there are no young pines, but a lower stratum of young white spruces is a frequent sight. Barring fire, one may expect ascendancy of the spruce at the expense of the pine. In a well developed white spruce forest, it is not unusual to see large, old, and plainly dying pines—the remnant of the pine forest that once occupied the site. Young pine forests that are burned appear most commonly to be succeeded by an abundant and immediate regrowth (from seed) of pine; burned mature pine forests appear to be succeeded commonly by aspen.

The following plants were collected or observed in jack pine forests: *Equisetum scirpoides, Lycopodium complanatum, Juniperus communis* var. *depressa, J. horizontalis, Bromus pumpellianus, Calamagrostis purpurascens, Elymus innovatus, Festuca saximontana, Oryzopsis asperifolia, O. pungens, Carex aenea, C. foenea, Zygadenus elegans, Calypso bulbosa, Corallorhiza trifida, Populus balsamifera, P. tremuloides, Salix bebbiana, S. glauca, Alnus crispa, Betula glandulosa, B. papyrifera, Geocaulon lividum, Arenaria capillaris, Anemone multifida, A. patens* var. *wolfgangiana, A. parviflora, Aquilegia brevistyla, Ribes lacustre, Amelanchier alnifolia, Fragaria virginiana* var. *terrae-novae, Potentilla fruticosa, Rosa acicularis, Astragalus americanus, Hedysarum alpinum* var. *americanum, H. mackenzii, Lathyrus ochroleucus, Oxytropis splendens, Empetrum nigrum, Hudsonia tomentosa, Shepherdia canadensis, Epilobium angustifolium, Cornus canadensis, Pyrola asarifolia, P. secunda, P. virens, Arctostaphylos uva-ursi, Ledum groenlandicum, Vaccinium vitis-idaea* var. *minus, Apocynum androsaemifolium, Pedicularis labradorica, Galium septentrionale, Linnaea borealis* var. *americana, Lonicera dioica* var. *glaucescens, Viburnum edule, Campanula rotundifolia, Arnica lonchophylla, Aster ciliolatus, A. sibiricus, Erigeron glabellus* var. *pubescens, Hieracium umbellatum, Senecio trideniculatus,* and *Solidago spathulata* var. *ncomexicana.*

## DECIDUOUS FORESTS

Three species of deciduous trees occur in the highway region: *Betula papyrifera, Populus balsamifera,* and *P. tremuloides.* The first of these, *Betula papyrifera* (paper birch), typically occurs scattered among *Picea glauca* and *Pinus banksiana;* locally on sand plains it may form small pure stands. In contrast, the two species of *Populus* occur not only as scattered individuals among other trees but they also may form extensive pure stands.

*Populus tremuloides* (aspen) stands appear to arise primarily following burning of more or less mature jack pine or white spruce forests. It is not at all unusual to find an island of unburned pine or spruce that is surrounded by burned forest in which a vigorous stand of young aspens is developing. Among the aspens the secondary flora may con-

tain many of the species found in the adjacent unburned forest, e.g., *Elymus innovatus*, *Geocaulon lividum*, *Fragaria virginiana* var. *terraenovae*, *Rosa acicularis*, *Rubus pubescens*, *Shepherdia canadensis*, *Cornus canadensis*, *Vaccinium vitis-idaea* var. *minus*, and *Viburnum edule*. *Epilobium angustifolium* is generally frequent to common, as are shrubby willows, especially *Salix bebbiana*. Typically there is little reproduction of aspen, but young white spruces—frequently with a mixture of *Populus balsamifera*—may be common. A mature aspen woods is floristically similar to a mature jack pine woods. It may contain large old pines, which apparently are trees that survived the fire that destroyed the original pine forest. *Populus balsamifera*, poplar, forms pure stands on flood plains, where a poplar stage immediately precedes white spruce. Such stages can be seen along the Hay River, which parallels the Mackenzie Highway in northern Alberta and in the Northwest Territories. Along the Yellowknife Highway a "typical" flood plain (but one of quite limited area) was seen only along the Kakisa River just below Lady Evelyn Falls. Otherwise, poplar occurs generally in mixture with white spruce; it may locally be dominant or may form pure stands of limited extent. Along streams in white spruce forests, poplar may be especially common. The flora of poplar dominated areas is similar to the flora of the adjacent areas that are dominated by white spruce.

## VEGETATION OF ROCK OUTCROPS

### LIMESTONE OUTCROPS

Along the Enterprise-Frank Channel section of the highway many outcroppings of limestone occur. The exposures may be vertical only—as on the faces of the gorge immediately below Lady Evelyn Falls—or both vertical and horizontal—as in many places between miles 10 and 28 where the descending great limestone "stairs" of the northern edge of the Alberta Plateau are exposed over large areas. Outcrops occur also between miles 80 N and 107 N—here the exposures are largely horizontal or gently inclined—and in the cliffs near mile 127 N, where the slope below the limestone cliff is littered with small to huge limestone blocks and slabs. My notes on the flora of limestone outcrops were derived principally from investigation of horizontal exposures at miles 20 to 28, 80.8 N, 96.5 N, 103.5 N, and 107 N.

Limestone outcrop areas are characterized by much exposed rock and, in places, by the presence of a fine, dark brown, residual, non-calcareous soil. The soil may be confined to crevices or may exist in a shallow layer (typically 1 to 4 inches deep) over the rock. A large percentage of such soil is typically bare of plant cover. In some areas, a litter layer up to about 1 inch deep may accumulate. Lichens are common to abundant in outcrop areas, both on bare rock and on soil. The most apparent species are the fruticose *Cladonia alpestris*, *C. mitis*, *C. rangi-*

*ferina,* and *Cetraria nivalis.* An occasional patch of *Cetraria tilesii* is conspicuous because of its bright yellow color.

Trees, when present, are typically widely spaced. *Pinus banksiana* and *Populus tremuloides* are the commonest species; *Picea glauca* is less common; and *Picea mariana, Populus balsamifera,* and *Betula papyrifera* are uncommon. Many outcrop areas have no trees on them. Especially characteristic of the outcrops is the conspicuousness of the chamaephytes *Juniperus horizontalis, Saxifraga tricuspidata,* and *Arctostaphylos uva-ursi.* In many places the long (up to 20 feet) prostrate branches of *Juniperus horizontalis* criss-cross each other, forming a distinctive network on the rock. *Saxifraga tricuspidata* forms circular mats up to 2 feet across, often with the innermost portion of the mat dead. The prostrate branches of *Arctostaphylos uva-ursi* reach 6 feet in length. Of the erect shrubs on limestone outcrop areas, *Juniperus communis* is the most common; it forms on many sites a distinct low-shrub stratum. Other common shrubs are *Amelanchier alnifolia, Potentilla fruticosa, Prunus pensylvanica, Rosa acicularis,* and *Shepherdia canadensis. Prunus virginiana,* notable because it is here at the northermost known portion of its range, is local, forming thickets or occurring as isolated shrubs.

On the limestone cliffs at Lady Evelyn Falls, and on the moist faces of limestone escarpments between miles 10 and 28, the ferns *Cystopteris fragilis, Dryopteris robertiana* (seen only at mile 15.5) and *Woodsia glabella* are found and may be common locally. The *Cystopteris* and the *Woodsia* occur also at the Mosquito Creek cliffs, along with *Cryptogramma crispa* var. *acrostichoides, Polypodium virginianum,* and *Woodsia ilvensis* (the last-named three, however, are much more common on Pre-Cambrian rocks). On the Mosquito Creek cliffs the few trees are *Picea glauca, P. mariana,* and *Betula papyrifera. Salix glauca,* to about 8 feet tall, is present. The most common plant there is *Dryas integrifolia,* which forms mats on both vertical and horizontal rock faces. Two crucifers, *Draba cinerea* and *Lesquerella arctica* var. *scammanae,* and a sedge, *Carex glacialis,* found in crevices, were collected only at Mosquito Creek.

Vascular plants collected or observed on limestone outcrops are: *Cystopteris fragilis, Dryopteris robertiana, Polypodium virginianum, Woodsia glabella, W. ilvensis, Juniperus communis* var. *depressa, J. horizontalis, Picea glauca, P. mariana, Agropyron trachycaulum, Agrostis scabra, Calamagrostis inexpansa, C. neglecta, C. purpurascens, Deschampsia cespitosa, Elymus innovatus, Festuca saximontana, Helictotrichon hookeri, Koeleria cristata, Oryzopsis pungens, Poa alpina, P. canbyi, P. glauca, P. interior, Carex bebbii, C. concinna, C. glacialis, C. scirpoidea, Juncus alpinus, J. balticus* var. *littoralis, Allium schoenoprasum* var. *sibiricum, Zygadenus elegans, Sisyrinchium montanum, Populus tremuloides, Salix arbusculoides, S. bebbiana, S. glauca, Betula*

*papyrifera, Arenaria capillaris, A. dawsonensis. A. rubella, Cerastium arvense, Melandrium ostenfeldii, Anemone multifida, A. parviflora, A. patens* var. *wolfgangiana, Arabis divaricarpa, A. holboellii, Draba cinerea, D. lanceolata, Lesquerella arctica* var. *scammanae, Ribes oxyacanthoides, Saxifraga tricuspidata, Amelanchier almifolia, Dryas drummondii, D. integrifolia, Fragaria virginiana* var. *terrae-novae, Geum triflorum, Potentilla arguta, P. fruticosa, P. nivea* ssp. *hookeriana, P. pensylvanica, Prunus pensylvanica, P. virginiana, Rosa acicularis, Hedysarum mackenzii, Oxytropis campestris* var. *varians, O. splendens, Linum lewisii, Shepherdia canadensis, Cornus canadensis, C. stolonifera, Arctostaphylos uva-ursi, Androsace septentrionalis, Dodecatheon pulchellum, Gentianella amarella* ssp. *acuta, Castilleja raupii, Rhinanthus crista-galli, Plantago septata, Galium septentrionale, Lonicera dioica* var. *glaucescens, Campanula rotundifolia, Achillea lanulosa, Antennaria parvifolia, Arnica lonchophylla, Artemisia campestris* ssp. *borealis, Aster alpinus* var. *vierhapperi, A. ciliolatus, A. hesperius* var. *laetevirens, Erigeron compositus* var. *glabratus, E. glabellus* var. *pubescens, Helenium autumnale, Hieracium umbellatum, Senecio tridenticulatus, Solidago spathulata* var. *neomexicana,* and *Taraxacum ceratophorum.*

## PRE-CAMBRIAN OUTCROPS

Along the Frank Channel-Yellowknife section of the highway Pre-Cambrian outcrops become a dominant feature of the landscape. These outcrops, with perpendicular to gently sloping sides and with rounded to more or less flat or undulating summits, rise several to about 300 feet (average 100 feet) above the surrounding terrain. Some of them ascend in a series of stair-like levels. The bases of the outcrops are overlain with mineral soil (principally silt and clay, but also some sand and gravel). Clothing the soil are pure or mixed stands of *Picea glauca, P. mariana, Populus tremuloides,* and *Betula papyrifera,* and thickets of *Salix* spp., *Alnus crispa, Rosa acicularis, Shepherdia canadensis,* and *Viburnum edule.*

The rock composing the outcrops is largely granite-gneiss, granodiorite, and granite except in the Yellowknife area, where volcanic, sedimentary, and metasedimentary rock types occur. The outcrops show a wide range of colors, including pink, dark green, dark grey, and almost black. The natural color of the rock is, however, obscured by weathering and, even more important, by an abundance of saxicolous lichens. Of these the pale dull greens and yellows of *Cladonia* and *Cetraria,* the ashy grey of *Parmelia,* and the blacks of *Actinogyra* and *Lasallia* are the most characteristic. The rock tripes (i.e., *Actinogyra* and *Lasallia),* black when dry, become a dark olive when they get wet. Outcrops covered with rock tripe become markedly different in aspect during the first few minutes of a rainfall: they change slowly—but most perceptibly—from black to dark olive as the lichens absorb moisture. On out-

crops covered with other lichens, the colors become more intense during a rain. Lichens collected on Pre-Cambrian outcrops include: *Cladonia alpicola, C. cornuta, C. degenerans, C. metacorallifera, C. mitis, C. pyxidata, C. rangiferina, C. uncialis, C. verticillata, Actinogyra muhlenbergii, Lasallia pensylvanica, Cetraria nivalis, Parmelia centrifuga, P. stenophylla,* and *P. sulcata.*

Crustose lichens and rock tripe are best represented on cliff faces, slopes, and the most exposed level places; fruticose lichens tend to be most abundant in more sheltered places, especially shallow depressions, where a few inches to several square feet may be covered by an unbroken mat of *Cladonia* and *Cetraria.* In somewhat deeper depressions, xerophytic matted moses (especially *Polytrichum formosum, P. juniperinum, P. piliferum,* and *Hedwigia ciliata)* tend to be dominant over lichens. A layer of fine, dark brown, peaty soil, to about 2 inches thick, can be observed under such moss and lichen mats. Soil accumulation under mosses appears to be greater than under lichens. Such soil serves as a seed bed for higher plants.

The vascular flora of Pre-Cambrian outcrops is poor in species and, for the most part, in individuals. The outcrops offer two types of habitats for vascular plants: (1) rock crevices, and (2) depressions. The commonest trees are *Pinus banksiana, Picea mariana,* and *Betula papyrifera; Picea glauca* and *Larix laricina* are infrequent. These trees grow either in crevices (where jack pine, white spruce, and white birch are commonest) or in peaty depressions (where black spruce and larch are commonest). The trees are typically small and stunted, ranging between 6 and 20 feet tall, although larger specimens can be found (e.g., the largest jack pine found by me on a Pre-Cambrian outcrop was about 40 feet tall and 13 inches DBH; it had 135 annual rings). In the most exposed situations, only jack pine and black spruce are found; here they are gnarled, sometimes almost prostrate or with all but the lowest branches killed.

In rock crevices wherein a little soil has accumulated, the commonest vascular plants are *Cryptogramma crispa* var. *acrostichoides, Dryopteris fragrans, Polypodium virginianum, Woodsia ilvensis, Juniperus communis* var. *depressa, J. horizontalis, Saxifraga tricuspidata, Empetrum nigrum, Arctostaphylos uva-ursi,* and *Vaccinium vitis-idaea* var. *minus;* less common to rare are *Festuca saximontana, Carex canescens, C. supina, Melandrium ostenfeldii, Potentilla multifida, P. nivea* ssp. *hookeriana,* and *P. pensylvanica.* These are also the first of the higher plants to become established in lichen and moss mats in depressions. It is not unusual to see a moss- or lichen-dominated depression (with a well-formed soil layer under the mat) in which just one or two species of herbaceous vascular plants (and often only one or two individuals) are growing, e.g., *Agrostis scabra, Calamagrostis canadensis, Poa interior, Carex aenea, C. chordorrhiza, Eriophorum, angustifolium, E. brachy-*

*antherum, Smilacina trifolia, Geocaulon lividum, Corydalis sempervirens,* and *Arabis holboellii.* A considerable layer of peaty soil (2 feet in one site investigated) can accumulate in these depressions, and a shrub or shrub-tree community develops therein. The most common dominant shrubs are *Ledum decumbens, L. groenlandicum,* and *Chamaedaphne calyculata.* Less common to rare shrubs are *Salix bebbiana, S. pyrifolia, Alnus crispa, Ribes glandulosum, R. oxyacanthoides, Amelanchier alnifolia, Dryas drummondii, Potentilla fruticosa, Rosa acicularis, Rubus idaeus* var. *canadensis, Shepherdia canadensis, Vaccinium uliginosum,* and *Viburnum edule.* The most common tree is *Picea mariana.* Among other plants found in such depressions are *Equisetum sylvaticum, Rubus chamaemorus, Epilobium angustifolium, Artemisia campestris* ssp. *borealis,* and *Solidago spathulata* var. *neomexicana.*

## VEGETATION OF LAKES AND RIVERS

### MARLY LAKES

Along several sections of the Great Plains portion of the highway are many small lakes that are notable because of the large amount of lake marl ($CaCO_3$) precipitated from their water and because of the consequent deposit of marl that develops on the bottom. Many of these marly lakes were studied between miles 40 and 66 and between miles 40 N and 90 N. The marly lakes occur in areas where calcareous bedrock is exposed. Carbonates dissolved from the rock by streams passing over it are carried into the lakes. Precipitation in the lakes is brought about by plant life, which uses carbon dioxide, causing supersaturation. A sample of marl from a small drained lake at mile 66 was sent to the Geological Survey of Canada for analysis. Dr. J. Terasme informed me that the sample was 90% or a little more acid soluble and that it contained a rich diatom flora, including, among the many genera and species, *Navicula tuscula, Achantidium flexellum, Pinnularia, Eunotia, Cymbella, Nitzschia angustata, Stauroneis,* and *Fragilaria lapponica.* Also in the sample were fragments of pelecypods and gastropods and many kinds of pollen and spores. *Pinus banksiana* was the predominating pollen (80-90%); others included *Picea glauca* (15-20%), *P. mariana* (1-3%), various Cyperaceae, and *Shepherdia canadensis.* Spores included *Selaginella, Lycopodium, Equisetum,* and *Sphagnum* and other mosses.

For the purpose of this discussion, I recognize two types of marly lakes: (1) those around which a sedge mat develops; and (2) those with gravelly-marly beaches.

The marly lakes found between miles 40 and 66 exhibit the development of a sedge mat. Open water in these lakes varies from only a few square feet in the nearly obliterated lakes to several acres in the larger ones. The water is crystal clear, and, even in the largest lakes, only a

foot or less of this water overlies the marl on the "bottom." Actually, the marl on the "bottom" is far from solid; it is, in contrast, loosely suspended in the water. It offers little resistance to the passage of objects (stick, stone, hand, etc.) through it. In some lakes, the deposit of marl is about 3 feet thick; in others, I was unable to reach the underlying layer with an 8 foot pole. Underlying the marl (at least those deposits whose bottom I was able to reach with a pole) is a hard layer, probably limestone.

The vegetation around marly lakes can be grouped into four more or less concentric zones: (1) vegetation of open water; (2) a sedge zone, i.e., the foremat, which is dominated solely by sedges; (3) a shrub zone, the next older portion of the mat, which is dominated by various low shrubs; and (4) a typical muskeg forest of black spruce.

In the marly lakes the following plants were found free-floating in shallow water beyond the edge of the mat: the mosses *Campylium stellatum* and *Scorpidium scorpioides; Utricularia intermedia,* and *U. vulgaris.* Plants rooted, albeit loosely, in marl in shallow water beyond the mat were: *Equisetum palustre, Sparganium minimum, Potamogeton filiformis* var. *borealis, Triglochin maritima, T. palustris, Carex aquatilis, C. lasiocarpa, C. limosa, C. physocarpa, Eriophorum angustifolium, E. chamissonis, E. viridi-carinatum, Scirpus validus, Juncus stygius* var. *americanus, Drosera anglica,* and *Menyanthes trifoliata.*

The mat is built up primarily through the activity of rhizomatous species of *Carex,* especially *C. aquatilis, C. buxbaumii,* and *C. lasiocarpa. Carex limosa* is important in places. The rhizomes of these species may extend 2 to 3 feet into open water beyond the edge of the mat. The mats may extend themselves quite rapidly over open water: in August of 1959, the inner edge of a mat at mile 44 was 37 feet from a marked small tree of *Larix laricina;* in August of 1961 it was 40 feet away from the tree. In most marly lakes it is possible to walk—or rather to wade—to within 4 or 5 feet of the leading edge of the mat without breaking through the hummocky tangle of rhizomes, roots, culms, and leaves comprising the mat. The mat becomes considerably firmer in its older portions because of the build-up of organic matter and the continued precipitation and accumulation of marl under the mat. *Scirpus cespitosus* var. *callosus* may become dominant in older portions of the mat.

In addition to the dominant sedges, relatively few plants can be found in the sedge zone. These grow either in the shallow water between the hummocks or on the hummocks themselves. The mosses *Campylium stellatum* and *Drepanocladus vernicosus* may be common. *Eriophorum chamissonis* is locally an aspect dominant. Other plants, infrequent to rare, are *Triglochin maritima, T. palustris, Muhlenbergia glomerata* var. *cinnoides* (on anthills), *Carex capillaris, C. diandra, C. interior, C. rostrata, Eriophorum angustifolium, E. viridi-carinatum, Tofieldia glutinosa, T. pusilla, Parnassia multiseta, Potentilla palustris,*

*Andromeda polifolia, Pinguicula vulgaris, Utricularia intermedia, U. vulgaris, Galium labradoricum,* and *Lobelia kalmii.*

The woody plants that dominate the shrub zone typically begin to appear as isolated individuals in the sedge zone, especially toward the outer edge of this zone. *Myrica gale* is generally the most common invader, although *Salix athabascensis, S. candida,* and *S. serissima* occur also. In the shrub zone itself, the commonest species are *Myrica gale, Betula glandulosa,* and *Potentilla fruticosa;* less common are the willows *Salix athabascensis, S. candida, S. pedicellaris,* and *S. serissima.* The sedges of the preceding zone persist to some degree, but the plants are for the most part scattered and not vigorous, especially in the older parts of the shrub zone. The shrubs grow on peaty hummocks (which were, of course, formed by the sedges), and the hummocks themselves are underlain by several inches of additional peat; below the peat is marl. Other than the shrubs, relatively few plants grow in the shrub zone. Probably the most common are mosses, of which I collected four species: *Ditrichum flexicaule, Dicanum bergeri, Campylium stellatum,* and *Tomenthypnum nitens.* Occasional clumps of *Sphagnum* occur in the older parts of the zone, as do occasional small trees of *Larix laricina* and *Picea mariana.*

Succeeding the shrub zone is typically a muskeg forest of *Picea mariana,* perhaps with some *Larix laricina.* The transition between the shrub zone and the muskeg forest is generally a rather abrupt one. At the outer edge of the shrub zone the moss mounds of the forest rise 1 to 2 feet. One literally steps up into the muskeg forest. The mounds may be largely of *Sphagnum,* especially *S. fuscum* and *S. warnstorfianum,* or of other mosses, of which *Tomenthypnum nitens* appears to be common.

At about mile 65 N and miles 37 and 64 are marly lakes that do not exhibit the formation of a sedge mat, but have, in contrast, wide marly-gravelly beaches. The water in these lakes is deeper and the bottom is firmer than in the sedge-mat lakes. In shallow water along the shore of these lakes the plants noted were *Chara contraria, C. contraria* var. *hispidula, Potamogeton filiformis* var. *borealis,* and *Scirpus validus.* On the lower beach grew *Triglochin maritima, T. palustris, Scolochloa festucacea, Carex aquatilis, C. atherodes, Eleocharis pauciflora* var. *fernaldii,* and *Scirpus validus.* On the upper beach were collected *Calamagrostis neglecta, Carex aurea, C. garberi, C. scirpoidea, C. viridula, Salix brachycarpa, S. candida, Betula glandulosa, Rumex maritimus* var. *fueginus, Ranunculus sceleratus, Parnassia multiseta, Potentilla anserina, Rubus idaeus* var. *canadensis, Cicuta douglasii, Epilobium glandulosum* var. *adenocaulon, Dodecatheon pulchellum, Primula incana, Gentianella amarella* ssp. *acuta, Gentianella crinita* ssp. *raupii, Lomatogonium rotatum, Mentha arvensis* var. *villosa, Castilleja raupii, Aster*

*brachyactis, A ciliolatus, A. junciformis, Erigeron lonchophyllus, Senecio congestus,* and *S. pauperculus.*

## MUCK-BOTTOM LAKES

The commonest type of lake along the Canadian Shield section of the highway is characterized by a bottom of muck (i.e., organic detritus), by the usual presence of a mat in which *Carex* spp., *Drepanocladus* spp., *Calla palustris, Potentilla palustris,* and *Menyanthes trifoliata* are important components, and by the abundance of *Nuphar variegatum.*

In open water beyond the edge of the mat the most obvious plant is *Nuphar variegatum,* whose relatively large leaves, floating on the surface, may cover a significant percentage of the water. *Nuphar* grows in water up to 5 feet deep. *Nymphaea tetragona* var. *porsildii* was found by me among *Nuphar* in only one lake, although Ray Murdy tells me that in 1963 he observed the species "here and there" in almost all of the medium to large lakes he studied along the highway from mile 10 S to 39 S. Other rooted aquatics with floating leaves are infrequent but may be locally prominent: *Polygonum amphibium, Caltha natans,* and *Potamogeton gramineus.* Submerged aquatics, inconspicuous but sometimes abundant, include *Potamogeton alpinus* var. *tenuifolius, P. foliosus, P. friesii, P. pusillus, P. richardsonii, P. zosteriformis, Ceratophyllum demersum, Myriophyllum exalbescens, M. verticillatum* var. *pectinatum, Utricularia intermedia, U. minor,* and *U. vulgaris.* The mosses *Drepanocladus capillaceus* and *D. exannulatus* are common to abundant on the mucky bottom. Locally, *Lemna trisulca* forms great masses just below the surface of the water, and *Lemna minor* is common. Emergent aquatics, generally found in the shallow water just beyond the edge of the mat, are few, the most common being *Equisetum fluviatile, Sparganium angustifolium, S. minimum, Hippuris vulgaris,* and *Menyanthes trifoliata.* Others are *Sagittaria cuneata, Alopecurus aequalis, Scirpus validus, Cicuta douglasii,* and *Senecio congestus.*

The mat around muck bottom lakes is composed largely of rhizomatous species of *Carex,* especially *C. aquatilis, C. lasiocarpa, C. limosa,* and *C. rostrata.* The mosses *Drepanocladus aduncus, D. capillifolium, D. exannulatus,* and *Meesia tristicha* are also common to abundant. In many sites, a conspicuous zone of *Calla palustris, Potentilla palustris,* or *Menyanthes trifoliata* occurs at the leading edge of the mat and is sharply distinct from sedges of the mat because of its different color and coarser foliage. These three species, where they occur, are most important contributors to the mat. Their thick tangled rhizomes extend 2 to 3 feet into open water, as do those of the sedges. *Calamagrostis canadensis* is common, especially but not solely in the firmer portions of the mat. Locally, certain other rhizomatous plants are important: *Equisetum fluviatile, Typha latifolia, Eriophorum angustifolium, Eleoch-*

*aris palustris, Glyceria grandi, G. pulchella, Eriophorum angustifolium, E. chamissonis, E. gracile, Acorus calamus,* and *Hippuris vulgaris.* Other plants collected on sedge mats around muck bottom lakes are: *Carex canescens, C. diandra, Polygonum amphibium, Rumex occidentalis, Stellaria crassifolia, Ranunculus sceleratus, R. gmelinii, Parnassia multiseta, Cicuta bulbifera, C. douglasii, Epilobium glandulosum* var. *adenocaulon, Naumburgia thyrsiflora, Scutellaria galericulata* var. *epilobiifolia, Aster junciformis,* and *Senecio congestus.* In at least some of the lakes, permafrost is only a foot or so below the mat, even in late summer.

Succession beyond the sedge mat appears to culminate in either a white spruce-*Hylocomium* forest (infrequently) or a black spruce-*Sphagnum* forest (commonly). In succession to white spruce, the sedge mat is invaded first by shrubs, commonly *Myrica gale, Chamaedaphne calyculata,* or willows *(Salix bebbiana, S. glauca, S. planifolia, S. scouleriana,* or a mixture of these.) *Alnus tenuifolia* occurs occasionally. Thickets of these shrubs may occupy extensive areas around shield lakes. The shrub stage is succeeded by or intermingled with a stage in which *Betula papyrifera* is dominant but in which some *Populus tremuloides* may occur. In the *Betula* stage (and sometimes in the shrub stage), young white spruces appear. The succeeding white spruce stage is characterized by an abundance of woodland mosses (especially *Hylocomium splendens)* and by the presence of such "typical" plants as *Equisetum arvense, Alnus crispa, Salix glauca, Mitella nuda, Ribes triste, Empetrum nigrum, Cornus canadensis, Moneses uniflora,* and *Pyrola grandiflora.* In succession to white spruce, bog mosses *(Sphagnum)* do not appear to enter into the sere as they do in succession to black spruce.

Succession to black spruce is characterized mainly by the invasion of the mat by *Myrica gale, Chamaedaphne calyculata, Ledum groenlandicum,* and sometimes *Betula glandulosa,* and, in addition, usually by *Sphagnum* spp. Encroaching upon this shrub stage are mounds of *Sphagnum* that support "typical" black spruce forest vegetation.

Almost every conceivable variant of the above seres can be observed. One of the commonest is the invasion of the mat by willows and the encroachment upon the willows by the black spruce-*Sphagnum* community. *Sphagnum* does not appear here until it is seen in the *Sphagnum* mounds of the forest stage.

The water level of many of the lakes adjacent to the highway has been lowered by ditching; some lakes have been drained completely. In addition to the submerged plants that are thus left stranded to die, and to the emergent plants that may persist, the following were observed on such exposed and drying muck: *Agrostis scabra, Carex canescens, C. diandra, C. paupercula, Eleocharis acicularis, Juncus vaseyi, Salix* sp. (seedlings), *Rumex maritimus* var. *fueginus, R. occidentalis, Ranunculus gmelinii, R. sceleratus, Stellaria crassifolia, Barbarea orthoceras, Rorippa islandica, Potentilla norvegica, Potentilla palustris,* and *Galium trifidum.*

Many muck-bottom lakes in the Mackenzie River-Frank Channel section of the highway show vegetation similar to that of muck-bottom lakes in the Canadian Shield section, i.e., a sedge mat followed by a shrub stage and finally a black spruce-*Sphagnum* forest. Conspicuously lacking, however, are *Calla palustris* and *Nuphar variegatum; Potentilla palustris* and *Menyanthes trifoliata*, moreover, are much less important than they are in lakes on the shield.

## SANDY- OR MUDDY-BOTTOM LAKES AND RIVERS

In the highway region, aquatic vegetation is especially luxuriant in the Stagg River (mile 49 S). Here, in still or slowly flowing clear water, the following plants were observed: *Potamogeton gramineus, P. richardsonii* (in water to 4 feet deep), *Sagittaria cuneata, Sparganium angustifolium, Eleocharis acicularis, Lemna minor, L. trisulca* (forming great masses on the bottom), *Ranunculus aquatilis* var. *eradicatus, Callitriche hermaphroditica, C. palustris, Naumburgia thyrsiflora, Utricularia intermedia, U. minor, U. vulgaris*, and *Bidens cernua*.

In still, protected areas along the shore of Kakisa Lake and Kakisa River, *Potamogeton gramineus, P. richardsonii, P. vaginatus*, and *Hippuris vulgaris* occur in water up to 2.5 feet deep. In shallower water shoreward are found *Equisetum fluviatile, Potamogeton filiformis, Sparganium angustifolium, Sagittaria cuneata, Phalaris arundinacea, Carex aquatilis, C. rostrata, Eleocharis palustris, Scripus validus, Polygonum amphibium, Ranunculus circinatus* var. *subrigidus, Callitriche hermaphroditica, C. palustris, Myriophyllum exalbescens, Sium suave*, and *Utricularia vulgaris*. At the outlet of Kakisa Lake into Kansas River the water is choked with masses of *Potamogeton*.

Three aquatics were collected only in the vicinity of Yellowknife: *Isoetes echinospora* var. *braunii* (in Prelude Lake), *Subularia aquatica* (in Prelude and Prosperous lakes), and *Limosella aquatica* (in Prosperous Lake). Additional aquatics observed in the highway region in sandy or muddy substrata include *Sparganium minimum, Glyceria borealis, G. pulchella, G. grandis, G. striata, Scolochloa festucacea, Juncus bufonius, J. filiformis, Polygonum lapathifolium, Potentilla palustris*, and *Myriophyllum verticillatum* var. *pectinatum*.

## MAN-MADE EXCAVATIONS

In roadside ditches and man-made pools, all of which are yet relatively new, only a few species can be found, and generally only a few individuals of each. Observed in such habitats were *Typha latifolia, Sparganium angustifolium, S. minimum, Potamogeton alpinus* var. *tenuifolius, P. filiformis, P. pusillus, Sagittaria cuneata, Arctagrostis latifolia, Lemna minor, Ranunculus circinatus* var. *subrigidus, R. gmelinii, Caltha natans, Polygonum amphibium, Callitriche hermaphroditica, C. palustris, Elatine triandra, Myriophyllum exalbescens, M. verticillatum* var. *pecti-*

*natum, Hippuris vulgaris,* and *Senecio congestus.* Of these, *Typha latifolia* is the commonest. Many roadside pools have nothing but a colony of cattails in them. Most of the excavations that contain water have bottoms of mud—exceedingly soft mud.

## VEGETATION OF MARL AND GYPSITE DEPOSITS

During the course of construction of the highway, a number of marly lakes, both south of the Mackenzie River and in the Mackenzie River-Frank Channel section, were partly or completely drained, exposing sizeable marl deposits. Certain marl deposits, such as the extensive one at mile 39.7 N, apparently were exposed by natural lowering of lake water level. A drained lake above the highway at mile 119 N has in its bed a deposit of gypsite at least 3 feet thick. The deposit is surrounded by a fine example of bog forest; in the gypsite itself, only one plant *(Juncus balticus* var. *littoralis)* was growing, probably because of the short time the lake had been drained.

In marl deposits the plants occur in very open associations. In the deposit at mile 30, recently exposed by draining, a rather weedy flora has developed and is confined to the periphery of the deposit where the marl is driest. Toward the center of the deposit is standing water. Walking on the drier marl is much like walking on a firm, thick, sponge-rubber mattress; the walker sinks in the wetter marl. The following plants were observed here: *Calamagrostis canadensis, Hordeum jubatum, Carex diandra, C. media, Eleocharis palustris, Scirpus validus, Juncus alpinus, Urtica dioica* var. *procera, Arenaria dawsonensis, A. lateriflora, Ranunculus gmelinii, R. sceleratus, Arabis hirsuta* var. *pycnocarpa, Descurainia sophia, Rorippa islandica, Potentilla norvegica, Hippuris vulgaris, Epilobium glandulosum* var. *adenocaulon, Phacelia franklinii, Campanula rotundifolia,* and *Senecio congestus.* Of these, the *Epilobium* was by far the commonest plant, giving to the band of vegetation rimming the deposit a reddish cast because of its anthocyanous stems and leaves.

As an example of a marl deposit in a long-naturally-drained lake bed, the one at mile 110.5 N may be offered. The marl is much fissured, and large areas are bare of plants. Occasional pieces of gypsum occur in the marl. The most obvious plants are low, scattered shrubs: *Salix brachycarpa, S. candida, S. glauca, Betula glandulosa, Potentilla fruticosa, Shepherdia canadensis,* and *Arctostaphylos uva-ursi.* Other plants are relatively many in species but few in numbers of individuals of each species: *Bryum lacustre, Equisetum arvense, Triglochin maritima, T. palustris, Deschampsia cespitosa, Poa interior, Carex aquatilis, C. atherodes, C. capillaris, C. concinna, C. garberi, C. scirpoidea, C. viridula, Scirpus cespitosus* var. *callosus, S. pumilus* var. *rollandii, Habenaria hyperborea, Arenaria humifusa, Melandrium ostenfeldii, Anemone parviflora, Braya humilis, Dryas integrifolia, Castilleja raupii, Erigeron*

*hyssopifolius, E. lonchophyllus,* and *Solidago spathulata* var. *neomexicana.*

Additional plants observed in other marl deposits are: *Calamagrostis neglecta, Phalaris arundinacea, Poa glauca, P. pratensis, Puccinellia nuttalliana, Scolochloa festucacea, Carex physocarpa, C. sartwellii, Atriplex patula, Rumex maritimus* var. *fueginus, Lepidium bourgeauanum, Potentilla norvegica, P. pensylvanica, Lomatogonium rotatum, Mentha arvensis* var. *villosa, Scutellaria galericulata* var. *epilobiifolia, Achillea lanulosa, Antennaria parvifolia, Aster brachyactis, A. ciliolatus, A. junciformis, A. pansus, Lactuca pulchella, Senecio indecorus, S. pauperculus,* and *Taraxacum ceratophorum.*

## VEGETATION OF STRANDS AND ISLANDS

### KAKISA RIVER

Along the rocky shore of the Kakisa River and on gravel bars and islands in the river, four zones of vegetation may be distinguished: (1) a fore zone, characterized by the absence of woody plants and by local dominance of sedges (especially *Carex aquatilis), Calamagrostis,* or *Phalaris arundinacea,* and by scattered other herbaceous plants; (2) a shrub zone, characterized by dominance of *Salix, Cornus stolonifera,* and *Alnus tenuifolia;* (3) a deciduous-tree zone, characterized by dominance of *Populus balsamifera;* and (4) an evergreen-tree zone, characterized by *Picea glauca* and developing into a typical white spruce forest community. These zones intergrade somewhat, and all of them are not necessarily present at every site.

Detailed study was made of three low rocky islands in the Kakisa River about 3 miles below Lady Evelyn Falls. One of these islands supported only herbaceous vegetation of the "fore zone"; one, somewhat higher, had a central zone of shrubs in addition to the fore zone; the third, the highest, had a fore zone and a central shrub zone and, in this, a central band of *Populus balsamifera* in which several young white spruces (ca. 3 feet tall) were growing.

On island I, and at the periphery (fore zone) of the other two islands, were collected or noted all of the taxa of herbaceous plants that I found elsewhere in similar habitats along the river. Locally, in the fore zone vegetation, *Carex aquatilis, Calamagrostis canadensis, C. neglecta,* and *Phalaris arundinacea* grew in large patches. Other plants of this zone, typically much scattered and in several cases represented by only one or two individuals, were: *Equisetum fluviatile, E. palustre, Typha latifolia, Agropyron trachycaulum, Beckmannia syzigachne, Deschampsia cespitosa, Poa glauca, Carex rostrata, Juncus balticus* var. *littoralis, Chenopodium capitatum, C. glaucum* var. *salinum, Polygonum aviculare, P. lapathifolium, Rumex maritimus* var. *fueginus, Arenaria dawsonensis, Stellaria crassifolia, S. longipes, Ranunculus macounii, R. reptans, R. sceleratus, Corydalis aurea, Arabis hirsuta* var. *pycnocarpa, Cardamine*

*pensylvania, Erysimum cheiranthoides, Rorippa islandica, Potentilla anserina, P. norvegica, P. palustris, Geranium bicknellii, Cicuta douglassii, Sium suave, Epilobium glandulosum* var. *adenocaulon, Hippuris vulgaris, Naumburgia thyrsiflora, Gentianella crinita* ssp. *macounii, Mentha arvensis* var. *villosa, Stachys palustris* var. *nipigonensis, Veronica peregrina, V. scutellata, Plantago major,* and *Galium trifidum.*

The shrub zones on islands II and III were dominated by a dense growth of *Salix bebbiana, S. candida, S. lasiandra, S. planifolia, Alnus tenuifolia,* and *Cornus stolonifera.* Among the shrubs grew only a few herbs: *Zygadenus elegans, Arenaria lateriflora, Parnassia multiseta, Geum macrophyllum* var. *perincisum. Hedysarum alpinum* var. *americanum, Cornus canadensis, Castilleja raupii,* and *Aster junciformis. Rosa acicularis* occurred on island III. The shrubs formed a dense thicket and ranged from 4 to 25 feet tall (the latter height being reached only by *Salix lasiandra* and *S. planifolia).* The poplars on island III were growing among tall willows and were about 35 feet high and 8 inches DBH.

Similar stages of vegetation can be observed in many places along the Kakisa River. Just below Lady Evelyn Falls, the lower part of the "flood plain" is dominated by willows and alder; in this zone can be found small balsam poplars. The upper part of the plain is occupied by a typical white spruce-*Hylocomium* forest. The transition area between the willow-alder zone and the spruce forest exhibits particularly lush growth of shrubs and herbs, including *Actaea rubra, Aquilegia brevistyla,* three species of *Ribes, Amelanchier alnifolia, Cornus canadensis, Cornus stolonifera* (to 8 feet tall), *Pyrola grandiflora,* and *Viburnum edule* (to 5 feet tall).

## MACKENZIE RIVER

The bank of the Mackenzie River at Fort Providence and at mile 4 N (where the road to Fort Providence leaves the highway) is steep and is strewn with small to huge, more or less rounded boulders between which is sandy silt. At the lower part of the bank, the silt is damp and may be moss covered; higher up it is drier and may exhibit cracks. The habitat offered for plants is a rigorous one subject to much ice and water erosion; yet a surprising variety of plants grows on the river banks. In places, seemingly every available bit of space between the boulders is occupied by plants. The most obvious plants are shrubs, of which the following were noted: *Salix myrtillifolia, S. serissima, S. bebbiana, S. planifolia, Alnus tenuifolia, Ribes oxyacanthoides, Amelanchier alnifolia, Potentilla fruticosa, Rosa acicularis, Rubus pubescens, Elaeagnus commutata,* and *Cornus stolonifera.* Some small *Populus balsamifera* occur on the bank. The herbaceous flora, richer toward the base of the bank, contained the following taxa: *Equisetum arvense, Agropyron trachycaulum, Agrostis scabra, Beckmannia syzigachne, Cal-*

*amagrostis canadensis, C. inexpansa. Hordeum jubatum, Poa leptocoma, P. palustris, Sphenopholis intermedia, Carex aquatilis, C. atherodes, C. garberi, Eleocharis acicularis, Juncus balticus* var. *littoralis, J. alpinus, J. bufonius, Allium schoenoprasum* var. *sibiricum, Smilacina stellata, Sisyrinchium montanum, Arenaria lateriflora, Silene menziesii, Polygonum aviculare, Rumex maritimus* var. *fueginus, Anemone canadensis, A. multifida, Ranunculus macounii, R. reptans, R. sceleratus, Thalictrum venulosum, Erysimum cheiranthoides, Capsella bursa-pastoris, Rorippa islandica, Fragaria virginiana* var. *terrae-novae, Potentilla anserina, P. norvegica, Vicia americana, Viola nephrophylla, Epilobium glandulosum* var. *adenocaulon, Naumburgia thyrsiflora, Gentianella crinita* var. *raupii, Collomia linearis, Stachys palustris* var. *nipigonensis, Euphrasia* aff. *subarctica, Rhinanthus crista-galli, Plantago major, Galium septentrionale, Achillea lanulosa, A. sibirica, Arnica chamissois, Aster junciformis, Hieracium umbellatum, Lactuca pulchella,* and *Solidago canadensis* var. *salebrosa.*

## SANDY OR GRAVELLY BEACHES

Sandy gravelly beaches were observed only at Kakisa Lake and in the vicinity of Yellowknife. Such habitats are hazardous ones for plants because of ice accumulation and movement and because they are subject to flooding during high water in spring and to drying out later in the growing season.

At Kakisa Lake no woody plants were noted on the fore beach: the following herbaceous plants were seen: *Equisetum fluviatile, E. variegatum, Triglochin maritima, Calamagrostis inexpansa, Deschampsia cespitosa, Eleocharis acicularis, E. palustris, Scirpus validus, Juncus alpinus, J. balticus* var. *littoralis, J. bufonius, J. nodosus, Sisyrinchium montanum, Chenopodium glaucum* var. *salinum, Polygonum amphibium* (stranded), *P. lapathifolium, Ranunculus gmelinii, R. reptans, R. sceleratus, Erysimum cheiranthoides, Rorippa islandica, Potentilla anserina, P. norvegica, Epilobium glandulosum* var. *adenocaulon, Sium suave, Gentianella crinita* var. *macounii, Veronica scutellata, Plantago major, Achillea sibirica, Aster junciformis,* and *Erigeron philadelphicus.* These plants are all much scattered, except for the rhizomatous grasses and sedges, which form small colonies. The upper beach is characterized by the presence of low willows, *Salix lasiandra* and *S. planifolia,* and by a more continuous cover of grasses and sedges, especially *Carex aquatilis* and *Calamagrostis.* Above the upper beach is a zone of tall willows and *Alnus tenuifolia* in which an occasional poplar occurs and in which *Smilacina stellata, Zygadenus elegans, Thalictrum venulosum, Hedysarum alpinum* var. *americanum,* and woodland mosses were noted.

On sandy beaches of Prosperous and Prelude lakes, Frame Lake, and Yellowknife Beach (all near Yellowknife) the following taxa were noted: *Sparganium minimum* (stranded), *Triglochin maritima, T. palustris, Sagittaria cuneata, Eleocharis acicularis, Scirpus validus, Juncus*

*alpinus, J. bufonius, J. filiformis, J. vaseyi, Alopecurus aequalis, Beckmannia syzigachne, Glyceria borealis, G. grandis, Puccinellia distans, Carex aquatilis, C. rostrata, Polygonum lapathifolium, Rumex fueginus, Ranunculus cymbalaria, R. macounii, R. reptans, Sium suave, Veronica peregrina, Plantago major, Aster brachyactis,* and *Gnaphalium uliginosum.*

## VEGETATION OF SAND PLAINS

Occurring in the vicinity of Yellowknife and also just west of the shield margin at Frank Channel are areas that may be designated "sand plains." Here, on white or tan sand, the trees are *Pinus banksiana, Picea glauca, P. mariana,* and *Betula papyrifera.* In places, these species may all grow together; in other places, each may form pure stands. The trees are widely spaced and low branched, producing a parklike aspect. Considerable areas on the plains may be devoid of any vegetation or litter; some of these plant-free sites are blowouts. In other areas, the sand is covered with litter or, more commonly, with a dense greenish yellow mat of fruticose *Cladonia* and *Cetraria.* The plains that are dominated by such lichen woodland are strongly reminiscent of the parklike timber nearer to the continental limit of trees to the northeast.

Shrubby and herbaceous plants on the sand plains are few. The most common and characteristic shrubs are *Arctostaphylos uva-ursi, Ledum decumbens, L. groenlandicum,* and *Vaccinium vitis-idaea* var. *minus.* These may occur together or, more frequently, as isolated plants or small colonies. *Vaccinium vitis-idaea* var. *minus* appears to be the first woody plant to become established in blowouts. Other shrubs collected on sand plains are *Salix glauca, Rosa acicularis, Empetrum nigrum, Shepherdia canadensis, Hudsonia tomentosa,* and *Vaccinium uliginosum.* Of these, *Empetrum nigrum* and *Hudsonia tomentosa* are the most frequently encountered. *Empetrum* forms mats up to 3 feet across; *Hudsonia* is especially characteristic of the sand plains near the Yellowknife airport, where locally it is common, growing alone in otherwise bare sand or with *Arctostaphylos uva-ursi* or *Vaccinium vitis-idaea* var. *minus.*

Herbaceous plants collected on sand plains are *Equisetum sylvaticum, Lycopodium annotinum, Calamagrostis purpurascens, Festuca saximontana, Geocaulon lividum, Cornus canadensis, Astragalus striatus, Carex foenea, C. supina, Apocynum androsaemifolium,* and *Linnaea borealis* var. *americana.*

## VEGETATION OF DISTURBED SOIL

In the highway region, areas disturbed through the activity of man are mainly in the vicinity of the settlements (Enterprise, Fort Providence, Fort Rae, and Yellowknife) and along the highway right-of-way. To me, the outstanding characteristics of the vegetation of these sites are two: (1) the small number of introduced plants present; and (2) the persistence of native plants after disturbance.

Of all the species collected in disturbed habitats, only the following are certainly introduced: *Agropyron cristatum, A. repens, Bromus inermis, Phalaris canariensis, Phleum pratense, Puccinellia distans, Polygonum aviculare, Polygonum convolvulus, Axyris amaranthoides, Chenopodium glaucum* var. *salinum, Stellaria media, Brassica campestris, Capsella bursa-pastoris, Descurainia sophia, Erysimum cheiranthoides, Thlaspi arvense, Melilotus alba, M. officinalis, Lappula echinata, Galeopsis tetrahit* var. *bifida, Crepis tectorum, Matricaria maritima* var. *agrestis, Senecio vulgaris, Sonchus arvensis* var. *glabrescens, Tanacetum vulgare,* and *Taraxacum officinale.* These taxa, comprising about 5.5% of the total vascular flora, are decidedly uncommon along the highway right-of-way; indeed, finding one of them there is somewhat of an "event." Some of them, notably *Polygonum aviculare* and *Taraxacum officinale,* become more frequent in the vicinity of settlements. With the exception of *Puccinellia distans, Polygonum aviculare, Chenopodium glaucum* var. *salinum,* and *Erysimum cheiranthoides,* which grow sometimes in undisturbed habitats and appear native, all of them were found only in disturbed soil. It is to be expected, of course, that as time passes, these weeds will become more common along the highway (the oldest sections of which had been completed only five years when I last worked along them). Many of them are common to abundant along the older Mackenzie Highway.

What might be called the "settlement" flora is well represented at Enterprise (mile 0). Here, in disturbed sandy soil, occur many species of weedy plants, some native, some introduced. A similar flora can be found in waste places around each of the settlements. At Enterprise the species observed were: *Equisetum scirpoides, Agropyron trachycaulum, Agrostis scabra Hordeum jubatum, Oryzopsis pungens, Phleum pratense, Poa pratensis, Puccinellia nuttalliana, Carex aenea, Zygadenus elegans, Axyris amaranthoides, Chenopodium berlandieri* var. *zschackei, C. capitatum, Polygonum achoreum, P. aviculare, Rumex mexicanus, Cerastium nutans, Silene menziesii, Stellaria longipes, Aquilegia brevistyla, Corydalis aurea, Arabis holboellii, Capsella bursa-pastoris, Descurainia sophia, Erysimum cheiranthoides, Lepidium, densiflorum, Thlaspi arvense, Fragaria virginiana* var. *terrae-novae, Potentilla norvegica, Melilotus alba, Vicia americana, Geranium bicknellii, Epilobium angustifolium, E. glandulosum* var. *adenocaulon, Phacelia franklinii, Lappula echinata, L. redowskii* var. *occidentalis, Galeopsis tetrahit* var. *bifida, Moldavica parviflora, Campanula rotundifolia, Galium septentrionale, Achillea lanulosa, Aster ciliolatus, Aster sibiricus, Matricaria matricarioides, Crepis tectorum, Solidago canadensis* var. *salebrosa,* and *Taraxacum officinale.*

To list all the native plants that persist—and often do well indeed—in disturbed areas would require considerable space, for such a list would contain perhaps 90% of the species. Some of these just "manage to survive," being of reduced vigor in disturbed soil, e.g., *Smilacina trifolia,*

*Calypso bulbosa*, and *Spiranthes romanzoffiana*, which can be found on mounds of disturbed peat in clearings. Many others, in contrast, do exceedingly well and respond to their altered habitat with vigor. Outstanding examples are: *Allium schoenoprasum* var. *sibiricum*, *Zygadenus elegans*, *Arabis divaricarpa*, *Fragaria virginiana* var. *terrae-novae*, *Potentilla norvegica*, *Androsace septentrionalis*, *Campanula rotundifolia*, *Achillea lanulosa*, *Aster ciliolatus*, *Solidago multiradiata*, and *S. spathulata* var. *neomexicana*. These species are generally more to much more robust and abundant in disturbed areas than in adjacent undisturbed ones, where they may be rare and depauperate by comparison. The *Potentilla*, *Campanula*, *Achillea*, *Aster*, and two species of *Solidago* are in many places locally abundant in the right-of-way and are quite conspicuous when they are in flower.

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# PLATE I

(Upper) The Yellowknife Highway, mile 11. Forest of *Pinus banksiana* and *Picea glauca*. Limestone is just below the surface here, as is evidenced by tripod telephone poles (holes could not be dug to set poles).

(Lower) *Picea mariana-Hylocomium* forest along Kakisa Road, with road right-of-way in foreground.

# PLATE II

(Upper) *Picea glauca-Hylocomium* forest with scattered *Populus tremuloides*, mile 76. Highway in foreground.

(Lower) Interior of above forest, showing thick carpet of *Hylocomium splendens*.

## PLATE III

(Upper) Young *Pinus banksiana* forest, mile 30. Highway right-of-way in foreground.

(Lower) Mature *Pinus banksiana* forest, mile 34. *Elymus innovatus*, *Calamagrostis purpurascens*, and lichens *(Cladonia, Cetraria)* common.

# PLATE IV

(Upper) Edge of limestone outcrop area, mile 24. *Juniperus communis*, *J. horizontalis*, and *Arctostaphylos uva-ursi* common to abundant. *Picea glauca-Pinus banksiana* forest in background.

(Lower) *Juniperus horizontalis* on limestone, mile 24.

# PLATE V

(Upper) Limestone cliff, with talus, mile 66 S. Trees mainly *Picea glauca*.

(Lower) Pre-Cambrian outcrop about 10 miles east-northeast of Yellowknife. Trees are *Picea glauca*, *P. mariana*, *Pinus banksiana*, and *Betula papyrifera*. Lichens abundant.

# PLATE VI

(Upper) Pre-Cambrian outcrop, mile 37 S. Top of outcrop darkened by lichens *(Actinogyra* and *Lasallia).*

(Lower) Upper portion of above outcrop. *Pinus banksiana* on left, *Betula papyrifera* to left of center. Lichens (especially *Cladonia, Cetraria, Actinogyra,* and *Lasallia)* abundant.

## PLATE VII

Marly lake, mile 44, showing floating islands. Muskeg forest in background.

# PLATE VIII

(Upper) Muck-bottom lake adjacent to Canadian Shield section of highway. *Nuphar variegatum* common and in flower. Photo courtesy H. W. Murdy, United States Fish and Wildlife Service.

(Lower) Extensive sedge mat around muck-bottom lake, Canadian Shield section of highway. Photo courtesy H. W. Mudry, United States Fish and Wildlife Service.

## PLATE IX

Low island in Kakisa River just above highway bridge. Dominant plants are *Carex aquatilis*, *Calamagrostis canadensis*, and *Phalaris arundinacea*.

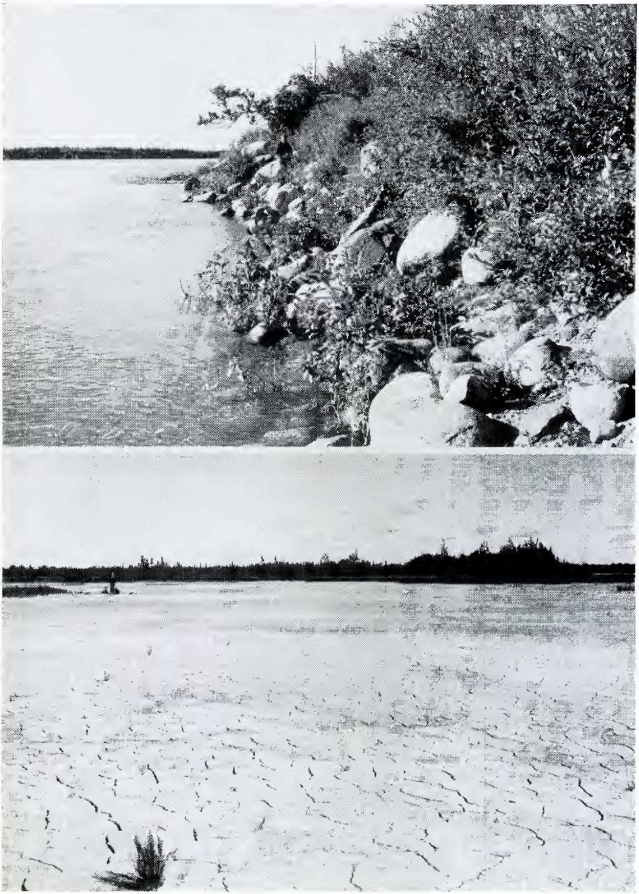
## PLATE X

Sandy gravelly beach of Kakisa Lake near outlet into Kakisa River. On mid-beach are willows; behind these is dense growth of taller willows and *Alnus tenuifolia*.

# PLATE XI

(Upper) Bouldery shore of Mackenzie River 4 miles east of Fort Providence. Shrubs are mainly willows and *Cornus stolonifera*.

(Lower) Extensive deposit of lake marl, mile 39.7 N.



# PLATE XII

(Upper) "Sand plain," mile 128 N. *Pinus banksiana* on right, *Betula papyrifera* on left. The white sand floor is carpeted with mounds of lichens, especially *Cladonia* and *Cetraria*.

(Lower) Close-up of lichen carpet on the "sand plain" pictured above.

# PLATE XIII

(Upper) Edge of "sand plain" near Yellowknife. Low plant on sand in foreground is *Hudsonia tomentosa;* trees in background are *Pinus banksiana* and *Picea glauca.*

(Lower) *Calamagrostis* grassland (prairie) with adjacent *Salix-Populus* woods, mile 16 N.